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A Summary of Selected Background Conditions for Inorganics in Soil

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TECHNICAL REPORT

A SUMMARY OF SELECTED BACKGROUND CONDITIONS FOR INORGANICS IN SOIL

Office of Chemical Safety
Illinois Environmental Protection Agency
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Introduction

The Office of Chemical Safety has completed a summary of selected background conditions for inorganic chemicals in surface soils in Illinois. The objectives of this project were as follows:

(1) to ascertain a reasonable indication of statewide background concentrations in soil of selected inorganic chemicals of public health and ecological interest;

(2) to support the Agency's efforts in determining the presence of elevated levels of lead in soil by determining the levels of lead present in selected background soils across the state; and

(3) to utilize, to the extent possible, existing site-specific studies and background data which represents a major data resource already existing within Agency files.

Technical Approach

The first step of this project involved the review of existing Agency files in order to obtain data on background concentrations in soil. The results were obtained from samples taken in areas, judged by the field staff taking the samples, to be undisturbed and unimpacted by site-related activities. No efforts were made to investigate these results relative to the potential for past sources of atmospheric deposition (e.g., smelter, leaded gasoline, etc.) or previous site activities at the background sample location. Certain areas of the state have likely been impacted by anthropogenic sources and therefore represent conditions

that may vary from naturally occurring levels. Sample results were obtained from Preliminary Assessment/Site Investigations performed since 1986 plus sample results from State and Federal Superfund site investigations in Illinois.

The second step in the process of generating this technical report involved the collection of additional samples. Surface soil samples were obtained by Agency staff from those counties in the State for which data were lacking. These samples were specifically taken from areas expected to represent naturally occurring background.

The current database includes 275 data points from sample locations in all 102 counties in Illinois. Since some of these sites required varying degrees of investigation, certain samples do not include the complete list of analytical parameters. As a result, each inorganic may have a different number of data points. The minimum concentrations, maximum concentrations, mean concentrations, and median concentrations were calculated for each of the inorganic parameters. Values which were reported as less than the detection limit were included in the summary statistics by using one-half of the detection limit. If upon analysis of these data, it could be concluded that the background sample had been impacted by site-related activities then the sample was not used in the summary data.

Data used in this report are laboratory analytical values for total metals determined by USEPA SW-846 methods. These methods convert all of each metal tested to a soluble ion that can be detected. Since the original ionic speciation of the metals are not known, conclusions regarding mobility, exposure, assimilations, and toxicity cannot be directly inferred.

It should be noted that uncertainties inherent in a report of this type include those due to variation in sampling procedures, variation in sampling depth, the use of one-half the detection limit for non-detects, differences in

analytical techniques between laboratories, and the impact of anthropogenic sources on the concentrations existing at the sample location. Furthermore, we wish to emphasize that the samples were not collected randomly nor in accordance with an a priori experimental design. Due to resource constraints, the majority of data used pre-existed this study. Consequently, this study is not and should not be characterized as having a totally unbiased scientific basis.

Results

Figure 1 shows the survey locations across the State. Table 1, 2, and 3 include an overall summary of the ranges, means, and medians calculated for the inorganic parameters. This overall data set includes samples from urban and rural locations.

Statewide Data -- Table 1 includes a summary of data obtained for the entire state. It should be noted that the statewide summary statistics should be used in conjunction with Tables 2 and 3. These breakouts of urban vs. rural counties indicate that certain inorganic parameters such as lead, zinc, and cadmium are generally higher in the urban environment.

Urban Data -- Table 2 includes data for counties within metropolitan statistical areas (MSAs) and Table 3 includes data for counties outside MSAs. MSAs are geographic areas consisting of a large population nucleus - a census-defined "urbanized area" - together with adjacent communities that have a high degree of economic and social integration with that nucleus. In MSAs with a population of one million or more, primary metropolitan statistical areas (PMSAs) may be identified. When PMSAs are defined, the MSA of which they are component part is redesignated a consolidated metropolitan statistical area (CMSA). Figure 2 shows the MSAs, PMSAs, and CMSA for Illinois.

The following inorganic constituents were detected in certain locations in the state at levels above the ranges for natural soils from the scientific literature: cadmium, lead, barium, mercury, thallium, and zinc.

Cadmium -- Those locations in the state where there is the greatest diversion from background levels published in the scientific literature for cadmium were in the counties of St. Clair and Lake. In St. Clair County, the levels of cadmium detected were highest in Sauget and Fairmont City where the levels detected were 7.3 mg/kg and 8.2 mg/kg, respectively. In Lake County, the highest level of cadmium was 7.4 mg/kg which was obtained from a background site in Waukegan.

Lead -- The highest levels of total lead identified during the survey were found in the counties of Cook and Lake. Two of the three highest detections for lead were in Chicago where the concentrations reported were 346 mg/kg and 647 mg/kg. The second highest concentration of lead detected was 384 mg/kg and was obtained in the City of Waukegan in Lake County.

Data Utilization

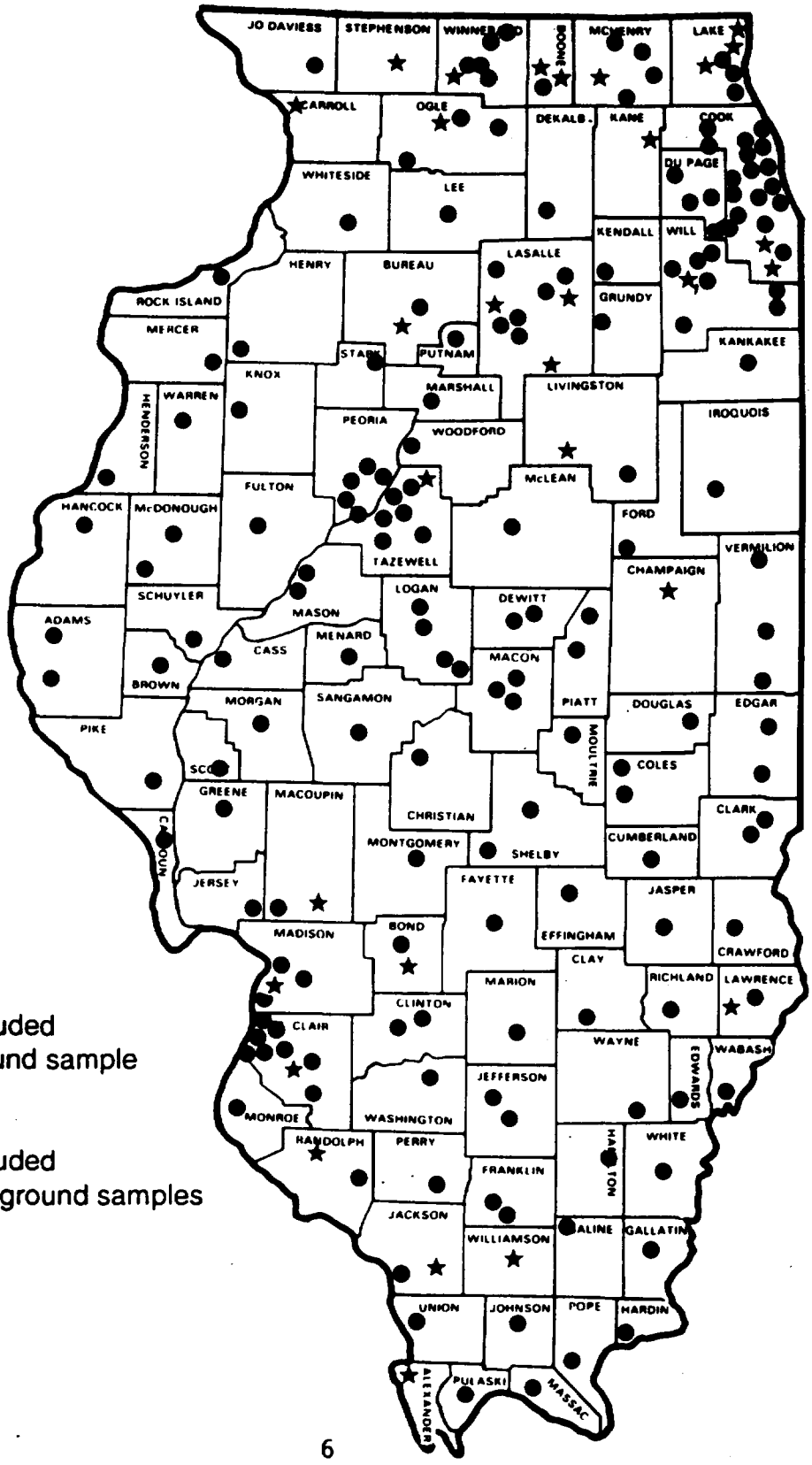
These data can be used by programs in the Agency to evaluate the plausible validity of any site-specific background data collected for various cleanup sites across the state. These data, however, are not meant to replace the collection of site-specific background data for sites.

A second use for these data is as a general screening check for determining the potential presence of inorganic contamination at a site. These data appear to present a reasonable indication of background conditions in Illinois and can be used to compare with site data. Doing so could identify any inorganic

contaminants which may be present in concentrations above what could be viewed as the "normal" range.

Figure 1

Sample Locations for Selected Background Samples for Inorganics in Soil

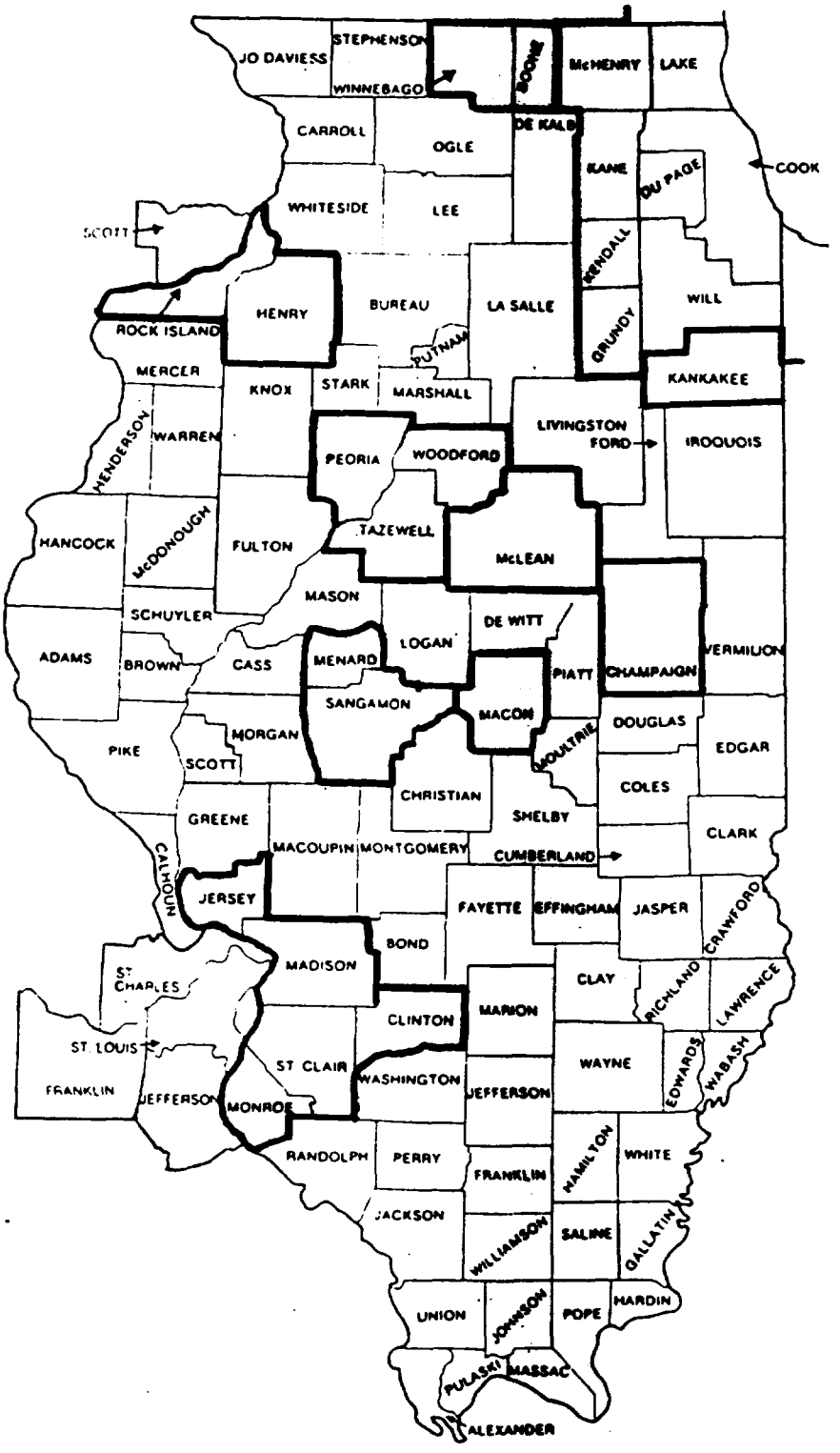


● Location included one background sample *(175 sites)*

★ Location included multiple background samples *(29 sites)*

FIGURE 2

Illinois Consolidated Metropolitan Statistical Areas, Primary Metropolitan Statistical Areas, Metropolitan Statistical Areas, and Counties



Aurora-Elgin, IL PMSA
Kane & Kendall Counties, IL
Bloomington-Normal, IL MSA
McLean County, IL
Champaign-Urbana-Rantoul, IL MSA
Champaign County, IL
Chicago, IL PMSA
Cook, DuPage, & McHenry Counties, IL
Chicago-Gary-Lake Cnty, IL-IN-WI CMSA
Aurora-Elgin, IL PMSA
Chicago, IL PMSA
Gary-Hammond, IN PMSA (Lake & Porter Cntys., IN)
Joliet, IL PMSA
Kenosha, WI PMSA (Kenosha Cnty., WI)
Lake County, IL PMSA
Davenport-Rock Island-Moline, IA-IL MSA
Henry & Rock Island Counties, IL (Scott Cnty, IA)
Decatur, IL MSA
Macon County, IL
Joliet, IL PMSA
Grundy & Will Counties, IL
Kankakee, IL MSA
Kankakee County, IL
Lake County, IL PMSA
Lake County, IL
Peoria, IL MSA
Peoria, Tazewell, & Woodford Counties, IL
Rockford, IL MSA
Boone & Winnebago Counties, IL
St. Louis, MO-IL MSA
Clinton, Jersey, Madison, Monroe, & St. Clair Counties, IL
Franklin, Jefferson, St. Charles, & St. Louis Cntys., MO;
St. Louis City, MO)
Springfield, IL MSA
Menard & Sangamon Counties, IL

Source: Illinois Statistical Abstract. 1991.

TABLE 1.

Summary Information for Total Concentrations of
Inorganic Chemicals in Background Soils in Illinois (mg/kg)

STATEWIDE DATA

Parameter	Number of Data Points	Range	Mean	Median
Aluminum	213	1388 - 37200	10126	9270
Antimony	142	0.18 - 8.6	3.7	3.6
Arsenic	234	0.35 - 24	6.7	5.9
Barium	251	ND (<5) - 1720	130	119
Beryllium	213	ND (<0.02) - 9.9	0.69	0.58
Cadmium	243	ND (<0.2) - 8.2	0.97	0.5
Calcium	213	630 - 184000	16443	6340
Chromium	261	ND (<2.14) - 151	17.3	14.0
Cobalt	214	0.9 - 32	8.9	8.8
Copper	254	1.0 - 156	19.7	14.0
Cyanide*	163	ND (<0.06) - 2.7	0.58	0.5
Iron	246	3200 - 80000	16190	15200
Lead	267	4.7 - 647	49.2	25.0
Magnesium	214	476 - 74500	7231	3410

TABLE 1. - CONTINUED

Parameter	Number of Data Points	Range	Mean	Median
Manganese	244	61.5 - 5590	767	631
Mercury	200	ND (<0.01) - 1.67	0.11	0.06
Nickel	252	ND (<3.1) - 135	16.8	14.1
Potassium	240	270 - 5820	1363	1120
Selenium	200	ND (<0.1) - 2.6	0.50	0.39
Silver	233	ND (<0.06) - 5.9	0.84	0.50
Sodium	205	14.1 - 7600	216	130
Sulfate	28	10 - 260	93.8	88.9
Sulfide	18	ND (<1.00) - 10.1	3.7	3.0
Thallium*	191	0.02 - 2.8	0.57	0.39
Vanadium	214	ND (<2.5) - 80	25.0	25.0
Zinc	246	ND (<5.5) - 798	102.9	67.4

* The total number of data points for cyanide (163) and thallium (191) are higher for the statewide data vs. the combined total from Tables 2 and 3 (158 and 183 respectively). This difference is due to the omission of certain data points in the MSA vs. non-MSA breakouts due to elevated detection limits (1/2 detection limit was higher than the highest detected concentration).

TABLE 2.

Summary Information for Total Concentrations of
Inorganic Chemicals in Background Soils in Illinois (mg/kg)

Counties **WITHIN** Metropolitan Statistical Areas

Parameter	Number of Data Points	Range	Mean	Median
Aluminum	103	1388 - 37200	10148	9500
Antimony	67	0.24 - 8	4.2	4.0
Arsenic	114	1.1 - 24	7.4	7.2
Barium	109	ND (<5) - 1720	133	110
Beryllium	99	0.05 - 9.9	0.73	0.59
Cadmium	104	ND (<2.5) - 8.2	1.3	0.6
Calcium	103	813 - 130000	20783	9300
Chromium	114	ND (<2.14) - 151	21.2	16.2
Cobalt	103	2.1 - 23	8.8	8.9
Copper	107	ND (<2.93) - 156	28.9	19.6
Cyanide	81	ND (<0.07) - 2.7	0.64	0.51
Iron	105	5000 - 80000	17607	15900
Lead	119	4.7 - 647	71.1	36.0
Magnesium	103	541 - 74500	10872	4820

TABLE 2. - CONTINUED

Parameter	Number of Data Points	Range	Mean	Median
Manganese	105	155 - 5590	742	636
Mercury	87	0.02 - 0.99	0.12	0.06
Nickel	105	ND (<3.1) - 135	20.9	18.0
Potassium	105	270 - 5820	1560	1268
Selenium	85	ND (<0.12) - 2.6	0.58	0.48
Silver	91	ND (<0.32) - 5.6	0.97	0.55
Sodium	97	20.2 - 1290	208	130
Sulfate	15	17.6 - 240	85.8	85.5
Sulfide	11	ND (<1.00) - 10.1	3.9	3.1
Thallium	78	0.02 - 1.6	0.46	0.32
Vanadium	103	ND (<2.5) - 80	25.0	25.2
Zinc	106	23 - 798	137.9	95.0

TABLE 3.

Summary Information for Total Concentrations of
Inorganic Chemicals in Background Soils in Illinois (mg/kg)

Counties **OUTSIDE** Metropolitan Statistical Areas

Parameter	Number of Data Points	Range	Mean	Median
Aluminum	110	2640 - 23300	10105	9200
Antimony	75	0.18 - 8.6	3.2	3.3
Arsenic	120	0.35 - 22.4	5.9	5.2
Barium	142	22.4 - 253	127	122
Beryllium	114	ND (<0.02) - 8.8	0.65	0.56
Cadmium	139	ND (<0.2) - 5.2	0.73	0.50
Calcium	110	630 - 184000	12379	5525
Chromium	147	4.3 - 37	14.3	13.0
Cobalt	111	0.9 - 32	8.9	8.4
Copper	147	1 - 42	13.0	12.0
Cyanide	77	ND (<0.06) - 1.2	0.46	0.50
Iron	141	3200 - 29100	15134	15000
Lead	148	ND (<7.44) - 270	31.5	20.9
Magnesium	111	476 - 24100	3853	2700

TABLE 3. - CONTINUED

Parameter	Number of Data Points	Range	Mean	Median
Manganese	139	61.5 - 3710	784	630
Mercury	113	ND (<0.01) - 1.67	0.10	0.05
Nickel	147	ND (<5) - 34.6	13.9	13.0
Potassium	135	280 - 5600	1210	1100
Selenium	115	ND (<0.1) - 1.7	0.44	0.37
Silver	142	ND (<0.06) - 5.9	0.76	0.50
Sodium	108	14.1 - 7600	222.8	130.0
Sulfate	13	10 - 260	103	110
Sulfide	7	ND (<1) - 8.8	3.4	2.9
Thallium	105	0.05 - 2.8	0.50	0.42
Vanadium	111	6 - 47	25.0	25.0
Zinc	140	ND (<5.5) - 400	76.3	60.2